the instructor in aeronautical meteorology at the U. S. Army School of Military Aeronautics at the Massachusetts Institute of Technology, has published a syllabus of his course of ten lectures,[8] and also the essentials of these ten as condensed into three lectures.[9] This presentation of "Meteorology and War-Flying" gives the essence of what the aviator needs to know, and contains full references to this rapidly developing application of meteorology. Major (formerly Professor) Wm. R. Blair has prepared a report on "Meteorology and Aeronautics,"[10] the purpose of which is "to show the sort of atmospheric data available and to put the subject in such shape as may make it bear directly on the problems which are met in aviation."

While the aviators were being trained, the Signal Corps was establishing its meteorological service abroad. As the first contingents of the American Army went overseas, Majors W. R. Blair and E. H. Bowie, appointed respectively from the aerological and forecasting divisions of the Weather Bureau, were put in charge of the meteorological work. In November those responding to a call for a large number of meteorologists were given a period of intensive training at more than a score of Weather Bureau stations. Professor W. J. Humphreys's new book, "The Physics of the Air," which is being published in the *Journal of the Franklin Institute,* was of great help to the more advanced students. This work is a highly valuable contribution to the science, for it covers the fundamentals of meteorology in such a way that it can be used readily as an advanced text-book.

More meteorologists are needed. So a Signal Corps School of Meteorology has been established at College Station, Texas. Here over 300 meteorologists, physicists, engineers and other technical specialists are about to begin an 8-week course in meteorology. Dr. Oliver L. Fassig, from the Weather Bureau at Baltimore and Johns Hopkins University, is chief instructor. There are to be three assistant instructors: Mr. W. T. Lathrop, from the Weather Bureau at Greenville, S. C., for instruments, observations and map-making; Lieutenant Wm. S. Bowen, for the aerological work; and Dr. C. F. Brooks, from Yale University, for the course in general meteorology. About thirty of the Weather Bureau men in the school will also assist in instruction.

In addition to this training of specialists—and perhaps induced thereby—are the short courses in meteorology included in the military instruction of the Reserve Officers Training Corps in many universities.

Meteorology in the navy has been developed by Lieutenant Commander Alexander McAdie, in charge of the aerographic section, and trained men are in service overseas and in this country. A school for men taking up this work is maintained at Blue Hill Meteorological Observatory under the guidance of L. A. Wells, chief observer and forecaster of the observatory.

Naval training units at the universities, are now, or will soon be, receiving instruction in marine meteorology.

The importance of meteorology has never before received such wide recognition, and in view of the permanent development of aeronautics, it seems safe to predict that hereafter it will always hold a more important position in the curricula of the universities.

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[8] SCIENCE, July 27, 1917, Vol. 46, N. S., pp. 84–85.

[9] *Mo. Weather Rev.,* Washington, December, 1917, Vol. 45, pp. 591–600.

[10] Report No. 13, 1917, National Advisory Committee for Aeronautics, Washington, D. C.

## SPECIAL ARTICLES

### CONCERNING SELECTIVE PERMEABILITY

IN most cases in living organisms, cell permeability does not even seem to violate the known physico-chemical laws. There are, however, several exceptions, notably in the intestines and kidneys, where the permeability is selective.

In considering the membranes that seem to disturb osmotic laws, it is often stated that they cause these disturbances because the

membranes are living, as though that were sufficient explanation. Are not the membranes that do obey the laws living, too? Those membranes through which certain substances can pass from a lower to a higher concentration are very probably different from the membranes used in experimental work. It is only by assuming that the membrane plays an active part in determining this one-sided permeability that the thermodyamic laws are brought into question. The sieve theory, even when so modified as to render negative osmosis[1] available, does not seem convincing. No gradation of molecules in the membrane, either of concentration or kind, allowing the solute to pass from one molecule to another, could possibly explain the facts. Nor does the theory of the funnel-like arrangement of lipin molecules,[2] ingenious though it be, allay one's curiosity. However, there is no doubt that most of the recent ideas on this question have been correct in postulating structures as a necessity in any explanation of this elusive (vitalistic) phenomenon.

Wherever selective permeability occurs there is at least one layer of cells through which the solute has to pass. It is inconceivable that if all parts of these cells were exactly alike there would be selective action. But there seems to be no theoretical difficulty provided certain differences exist. The two membranes in contact with the two fluids need to be different. The substance under consideration easily passes the membrane on the entering side of the cell, but passes either not at all, or with great difficulty the membrane on the exit side of the cell. In the cell a chemical change occurs in the substance that has entered. After this change it can pass the second membrane easily, but passes only with difficulty the membrane by which it gained entrance.

It is not necessary to assume a profound change to make conditions favorable for this differential solubility. But it is necessary that the substance formed should exist in higher concentration than the original substance when the two are in equilibrium. A change from an alkaline to a neutral or acid medium, involving a change from a sodium salt to the free compound or to, say, the chloride would be sufficient, or a synthesis of the entering compounds to more complex ones would suffice to make the theory plausible.

Because of our ignorance of just what happens in these membranes and cells, it can not be stated with certainty that specific changes do occur in a substance on passing through the cells and membranes. But the conditions necessary for such chemical and physical alterations seem to exist. The probabilities in this hypothesis can be more readily appreciated by taking an example.

The fats are hydrolyzed in the intestines to the sodium soaps. These sodium soaps, but not the fats, are able to pass the intestinal wall membrane. On entering the cell space inside the wall, the soaps are not free to pass on to the lymph or blood, because of the comparative impermeability of the second membrane to the soaps. While between these two membranes the soaps are synthesized to fats by the aid of enzymes in the presence of glycerol. Now these fats are able to pass through the second membrane to the lymph or blood; but the membrane on the intestinal side is comparatively impermeable to the fats. It is thus evident that there is reason for much higher concentration of fat in the lymph than in the intestines.

Though this illustration was chosen because it fits the theory, there is no inherent reason why the same conditions should not apply, say, to the absorption of the amino acids. They may be absorbed by intestinal cells as the sodium salts, then be changed to free amino acids, and pass thus to the blood. It is not necessary to assume that the compound exists in the same form in the blood as in the intestinal cell. It may change to any conceivable compound after passing the second membrane, may even change back to the one that passed the first membrane. There is more difficulty in accounting for the selective permeability of membrane cells in the case of rather

[1] F. E. Bartell, *J. Am. Chem. Soc.*, 36, 646 (1914).

[2] T. B. Robertson, SCIENCE, 45, 567 (1917).

inert chemical substances, such as the passage of sugars through the intestines or of urea through the kidney. But no decided changes in the molecules seem necessary. The conditions in the membrane cells may be favorable for weakly combined synthetic derivatives with the right solubilities. When we realize how susceptible to small differences in salts the membranes are, it is not impossible that some particular salt of the passing substance may be all that is necessary to determine its ready exit. If all other ideas fail in any given case, one can always fall back on the ever-ready help of the all-pervasive enzyme.

Several other writers have stated that these selective membranes behave as though a genie stood at the opening in the membrane, allowing the molecules from the side of lower concentration to pass, while closing the door to those moving in the opposite direction. It is evident that a space in which the proper chemical reaction occurs, and which is situated between the two different membranes with the proper permeabilities, functions like our anthropomorphic genie.

It is rather apparent that the idea outlined above is about half way between that of ordinary permeability and secretion. Though it does have many points in common with secretion, it seems wise not to confuse the two; for it is clear that they are different in the purpose served as well as in the method of obtaining their results.

If the attention is confined to the isolated system, solution one, the cell membrane as a whole, and solution two with concentration greater than solution one, the law of the conservation of energy is not obeyed. This might be urged as evidence of vitalism. But closer scrutiny will show that the necessary energy to run this system comes from outside. The substance necessary for the chemical reaction has to be formed and sent to the proper place. If this substance is derived from solution *two* directly, energy equivalent to that produced in the combination must be supplied to dissociate the complex. And energy is necessary to transport this substance back again to the permeability cell. Energy is also consumed in maintaining the cell structure. Even in a living organism one hesitates to start a perpetual motion theory, partly because it is such a lazy way of settling a difficulty, and partly because it would necessitate a later disillusionment.

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## THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

### SECTION B

THE section convened at Pittsburgh at 10 A.M., December 27, 1917, in Room 209 of the School of Applied Science, Carnegie Institute of Technology. Its sessions, jointly with those of the American Physical Society, extended over a period of three days. The scientific papers presented under the auspices of the American Physical Society are as follows:

"*The optical properties of rubidium*," by J. B. Nathanson, Carnegie Institute of Technology.

"*A preliminary study of the luminescence of the uranyl salts under cathode ray excitation*," by Frances G. Wick, Vassar College, and Louise S. McDowell, Wellesley College.

"*Note on a phosphorescent calcite*," by E. L. Nichols and H. L. Howes, Cornell University.

"*The visibility of radiation in the blue end of the visible spectrum*," by L. W. Hartman, University of Nevada (communicated from the Nela Research Laboratory, Cleveland).

"*An improved form of mercury vapor air pump*," by Chas. T. Knipp, University of Illinois.

"*Heat conductivity of cerium*," by C. N. Wenrich and G. G. Becknell, University of Pittsburgh.

"*Temperature and heat of fusion*," by J. E. Siebel, Chicago.

"*Report on the construction of certain mathematical tables*," by C. E. Van Orstrand, U. S. Geological Survey, Washington, D. C.

"*Mobilities of ions in vapors*," by Kia-Lok Yen, University of Chicago.

"*The size and shape of the electron*," by Arthur H. Compton, Westinghouse Lamp Company.

"*The coefficient of emission and absorption of photo-electrons from platinum and silver*," by Otto Stuhlmann, Jr., University of Pennsylvania.

"*Ionization and excitation of radiation by electron impact in nitrogen*," by Bergen Davis and F. S. Goucher, Columbia University.

"*Energy in continuous X-ray spectra*," by C. T. Ulrey, Columbia University.